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Performance Stability of Carbon-Supported *vs.* Metal-Black DMFC Catalysts

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Long-term stability of direct methanol fuel cells (DMFCs) is one of the most critical requirements for the successful DMFC commercialization. Previously, we suggested that interfacial delamination of electrodes from membrane (disulfonated poly(arylene ether) copolymer) can be one of main causes of performance degradation.[1,2] However, no significant delamination was observed in Nafion®-based MEAs after 100-hour life test, as evidenced by X-ray tomography analysis.[3]

In this work, we investigated the degradation phenomena of Nafion®-based MEAs during continuous DMFC operation. Cells were subjected to a 100-hour long life test at several different feed concentrations of methanol. *In-situ* cell high-frequency resistance (HFR) was measured under fully hydrated conditions. CO stripping measurements were conducted to probe the surface composition changes of the catalyst caused by Ru crossover from the anode to the cathode. Non-destructive X-ray tomography technique was used to examine structural changes in MEAs after the life test. **Figures 1** and **2** show cathode CO stripping voltammograms for different methanol feed concentrations after 100-hour life tests using metal black and carbon-supported catalysts, respectively. Most of Ru crossover takes place during a two-hour H_2-air break-in process and the dependence of the potentials of CO stripping on methanol concentration are insignificant in the following 100 hours of DMFC operation. MEAs with metal black catalysts reveal more severe Ru crossover relative to carbon-supported catalysts, which correlates well with the performance loss observed with the two catalysts.

HFR gain, Ru crossover, membrane structural change and electrode structural change after the life test as a function of methanol feed concentrations were systematically investigated and correlated with DMFC performance losses. The possible mechanism of DMFC performance degradation and mitigation strategies will be discussed in this presentation.

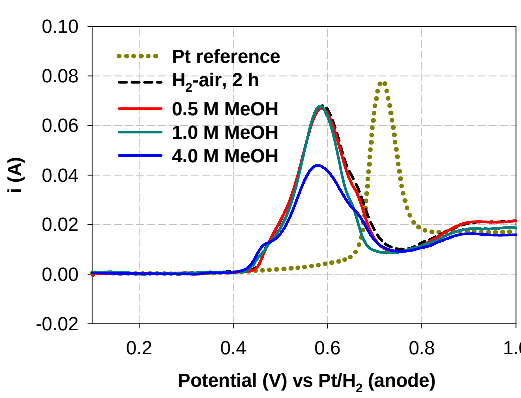

Figure 1. Cathode CO stripping curves at different methanol feed concentrations after 100-hour life test at 0.45 V. Anode: 6 mg cm^{-2} $Pt_{50}Ru_{50}$ black, 1.8 mL/min MeOH; Cathode: 4 mg cm^{-2} Pt black, 500 sccm air; Membrane: 3×Nafion® 212; Cell: 75ºC.

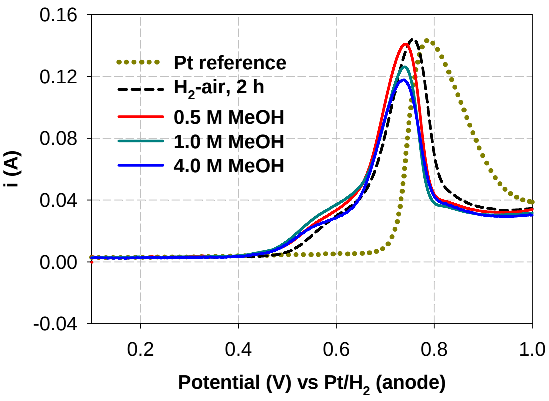

Figure 2. Cathode CO stripping curves at different methanol feed concentrations after 100-hour life test at 0.45 V. Anode: 4 mg_{metal} cm^{-2} HiSPEC® 12100, 1.8 mL/min MeOH; Cathode: 2 mg_{Pt} cm^{2} HiSPEC® 9100; 500 sccm air; Membrane: 3×Nafion® 212; Cell: 75ºC.

Acknowledgements

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References

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